The effects of applying a transmissibility correction to data collected by a strap mounted accelerometer

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Introduction: Data correction methods have been proposed to minimise the effects of local tissue-accelerometer vibration on data collected via skin mounted accelerometers [1]. It has been demonstrated that it is possible to measure the natural frequency (f_n) and damping ratio (ζ) for a strap mounted accelerometer system, in order to estimate an amplitude correction as a function of frequency [2]. The aim of this study was to apply an amplitude correction to tri-axial accelerometer data collected from a strap mounted accelerometer system.

Methods: One participant was fitted with a tri-axial strap mounted accelerometer (GENEActiv, Action; 100 Hz) at the 4th lumbar vertebrae (L4). A variation on the nudge test [1] was performed whereby the strap was pulled down by approximately 2 cm then released whilst the participant was in a standing position. The participant then wore the device at L4 to record acceleration during daily activity. One hour of accelerometer data was used to examine the effects of applying a transmissibility correction.

Vertical acceleration data from the nudge test were utilised to determine the f_n (11.37 Hz) and ζ (0.212) of the system [2]. An amplitude correction was estimated from Smeathers' transmissibility equation [1] (Figure 1a). Further data processing was carried out in our custom written software (GADget©, v2.1). Spectra of one hour of accelerometer data were calculated for the resultant acceleration, by performing Fourier transforms of contiguous rectangular frames of 5 seconds duration, on data with and without the transmissibility correction [1].

Results: The frequency spectra of one hour of accelerometer data with the transmissibility correction applied illustrated lower amplitudes as a function of frequency below 16.08 Hz (Figure 1b & c). For data without the transmissibility correction (Figure 1b) the spectrum plateaus above approximately 20 Hz as opposed to steadily increase when the correction was applied (Figure 1c).

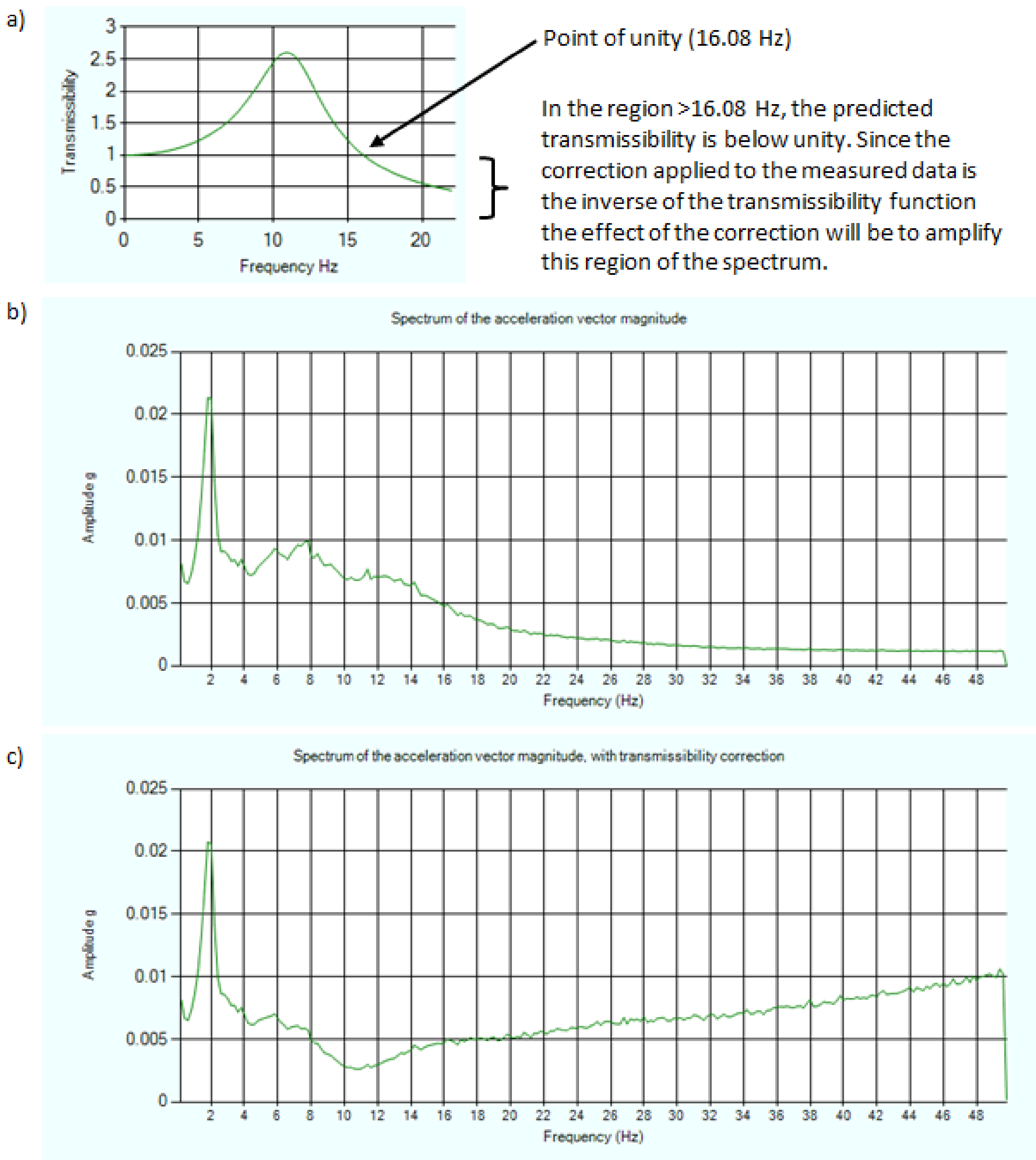

Figure 1: a) Transmissibility factor for natural frequency of 11.37 Hz and damping ratio of 0.212; b) Spectrum of the resultant acceleration without transmissibility correction; c) Spectrum of the resultant acceleration with transmissibility correction.

Discussion: When the transmissibility factor (Figure 1a) falls below unity (16.08 Hz), the predicted measurements will be attenuated by transmissibility and therefore the correction will amplify the result. This can explain the effect seen above 16.08 Hz in Figure 1c. The same value is also close to the frequency above which the uncorrected spectrum (Figure 1b) is nearly flat, which is a characteristic of random noise. This first attempt to correct strap mounted accelerometer data suggests Smeathers' transmissibility correction may be applied effectively up to the frequency threshold corresponding with the cut-off frequency of the transmissibility function, and thereafter is likely to amplify noise within the data.

Acknowledgements: Funding received from the University of Wolverhampton, Early Researcher Award Scheme

References:

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2. Smith, T, Baker, M & Foster, R. Proceedings of ISB XXVI, Brisbane, Australia, 2017.